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The analyses, opinions and findings of these papers represent the views of the authors, they are not necessarily those of the Banco de Portugal or the Eurosystem

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Global Value Chains: A View From the Euro Area*

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Abstract

This paper describes the main features of Global Value Chains (GVCs) in the euro area taken as a whole and compares with other large trade players like the US, China and Japan. In addition, the perspective of individual euro area countries is considered, with a focus on intra euro area linkages. The analysis relies primarily on the concept of foreign value added in exports, as a way to assess the pervasiveness of GVCs, it covers the period 2000-2011 and bases on the World Input-Output Database (WIOD). The paper finds that GVCs are important for the euro area as whole and they have rebounded after the great trade collapse. Moreover, there is a strong relevance of regional production linkages in Europe, with Germany playing a key role.

Keywords: International trade, Global Value Chains, Euro area
JEL Codes: F1, F14, F15

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1 Introduction

Global Value Chains (GVCs) became omnipresent in production processes around the world, especially in manufacturing sectors. This trend impacts not only on international trade between major blocks like the US, European Union (EU) and Asia but it has also risen the importance of regional linkages. As for the European regional production networks, important drivers were economic integration with Central and Eastern European economies and the creation of the euro area by a subset of EU countries.

The economic literature has been making progress in the measurement and mapping of this phenomenon. In the methodological front contributions have focused on the proposal of new indicators that measure the pervasiveness and assess the role of GVCs. Building on the initial contributions by Feenstra and Hanson (1999) and Hummels et al. (2001), broader frameworks for computing the foreign and domestic content in exports have been suggested by Koopman et al. (2010), Johnson and Noguera (2012*a*) and Stehrer (2012). Although the interpretation of trade in value added indicators is now essentially established, there is still insufficient work on the analysis of the results for regional trade blocks or individual countries along the time, geographic and sectoral dimensions. Some recent contributions along these lines are Johnson and Noguera (2012*b*) and Backer and Yamano (2012).

This paper takes a descriptive approach, comparing the main features of GVCs in the euro area with those of other very large economies, which also act as key players in international trade and as major currency areas (US, China and Japan). In addition, the perspective of individual euro area countries' is considered, with a special focus on intra-area linkages. The focus of the paper on the euro area bases on the notion that its economic adjustment mechanisms and trade ties are closer to those operating in US, China or Japan than to those of EU as a whole, because exchange rates are fixed and non-monetary integration dimensions are stronger. In short, the analysis of developments in GVCs in the context of the economic integration process in the euro area stands as the main research question.

The paper computes domestic and foreign value added embodied in a country's exports, making use of the concept of foreign value added content of exports (FVAiX) such as in Koopman et al. (2010) and Stehrer (2012). This concept improves on the measure of "vertical specialization" proposed by Hummels et al. (2001) as it takes into account the country of origin of value added contained in imported inputs used to produce goods and services that are subsequently exported, thus providing a deeper understanding of the characteristics of GVCs operating outside and inside the euro area. The analysis is based on the World Input-Output Database (WIOD), which

links national supply and use tables with bilateral trade data in goods and services to produce a unique global input-output table. This database builds on national official statistics, it covers 27 EU countries and 13 other major world economies and comprises 35 industries, corresponding to a broad NACE classification (see Timmer et al. (2012) and Dietzenbacher et al. (2013)). The paper focuses on the years 2000, 2007, 2009 and 2011. This final year is very relevant as it provides insights on GVCs' developments following the global economic and financial crisis period, which started in 2007 and strongly impacted international trade and in the overall macroeconomic situation of the euro area.

The results show that, in 2011, for the euro area taken as a whole, GVCs were as important as in China and more important than in the US and Japan. The high relevance of GVCs in the euro area, measured by the share of foreign value added in exports, is accompanied by their strong resilience in the face of the trade collapse. This contrasts with the developments observed in China, which may reflect GVCs with different characteristics. When euro area countries are taken individually, there is substantial heterogeneity in the development of GVCs from 2000 to 2011. Nevertheless, the foreign content of exports increased for more than half of euro area countries. In sectoral terms, the analysis shows that the services sector has increased its importance in GVCs of most countries. The results obtained for the euro area confirm the notion that GVCs have a strong regional dimension. In the period 2000-2011 the export share of foreign value added sourced within the euro area was more stable than that sourced from other blocks, representing around 11 per cent of total exports for the average euro area country throughout the period.

The paper is organized as follows. Section 2 presents the methodological framework to decompose value added in trade and reviews the interpretation of these measures. Section 3 focuses on the GVCs operating between the euro area as a whole and other major trade blocks, while section 4 looks at intra euro area value added flows. Next, section 5 looks at individual countries in order to identify common trends and differences in their supply linkages within and outside the euro area. Section 6 presents some concluding remarks.

2 Methodology

This section briefly reviews the methodology underlying the computation of the measure used in the paper to assess the pervasiveness of GVCs - the foreign value added content in a country's gross exports (FVAiX). In addition, the section presents the measures of domestic value added in exports (DVAiX) and re-exported domestic value

added in imports (RDVAiM), i.e., the exported domestic value added that returns back home (embedded in imports) and is subsequently exported.

The value of gross exports reported in the trade statistics exceeds the value added actually created in an economy in the production of its exports. The FVAiX belongs to the last generation of indicators that try to take account of this fact, i.e., indicators that aim to measure the value added created in foreign countries that was imported in the form of intermediates and, after some processing, was embodied in the country's exports. The recently available global input-output matrices, where country-sector pairs of inputs are disentangled along country-sector pairs of outputs, allow for the calculation of the FVAiX.

We base on Treffer and Zhu (2010) and Stehrer et al. (2012) for a simple presentation of the indicator. The global Leontief inverse matrix is denoted as $L = (I - A)^{-1}$, with dimension $NC \times NC$, where N stands for the number of sectors and C for the number of countries. The vector of value added coefficients, i.e., value added created per unit of gross output in country r , is denoted by v^r . This $1 \times NC$ vector contains the value added coefficients for country r and zeros otherwise. Further, country r 's exports are written in a vector e^r , which is of dimension $NC \times 1$ and reports the exports as positive elements and zeros otherwise.

The DVAiX basically picks the on-diagonal block in the Leontief inverse for country r , pre-multiplies with the value added coefficients in each sector and post-multiplies with the values of exports, that is:

$$\text{DVAiX}^r = v^r L^{rr} e^r \quad (1)$$

The FVAiX provides the value added directly and indirectly created in the country from which intermediates are imported (source country s) for production of country r 's exports and is calculated in a similar way. It implies pre-multiplying the Leontief inverse by the vector containing the value added coefficients for country s and zeros otherwise, denoted as v^s , and post-multiplying with country r 's exports vector. In other words, the FVAiX basically takes the off-diagonal blocks of the global Leontief inverse for country r , pre-multiplies with country s value added coefficients and post-multiplies with the vector of country r exports. Formally, this is written as:

$$\text{FVAiX}^{sr} = v^s L^{sr} e^r \quad (2)$$

Next, summing up over all partner countries, the total foreign value added embodied in country r 's exports is:

$$\text{FVAiX}^r = \sum_{s, s \neq r} v^s L^{sr} e^r \quad (3)$$

This expression is akin to the one suggested by Hummels et al. (2001) to calculate the import content of exports, designated as “vertical specialization”. However, in equation 3 the calculation is based on a value added concept and uses a global Leontief inverse, rather than a basic matrix with the country’s import coefficients.

Adding the domestic and the foreign value added in exports, as presented in equations 1 and 3, provides the value of total exports in gross terms. The same procedure described in equations 1 to 3 can be applied when the value added content of exports of a particular sector is analysed. In this case only the exports of the selected sector are included in the export vector e^r .

The calculations consider a country’s total exports, i.e., both exports of intermediates and final goods. Although intermediate goods do not account for the calculation of total value added, this is not the case for value added in exports. This is justified from a national accounting perspective because exports - irrespectively of being intermediate or final goods - are classified as final demand. In fact, to include only exports of final goods would be misleading. For example, a country exporting only raw materials would show virtually zero value added in exports, in a context where the production of raw materials genuinely creates domestic income. In other words, the consideration of exports of intermediate and final goods leads to double counting in overall trade statistics (which is one of the motivations for the proposal of value added measures) but from an individual country’s perspective both types of exports have to be considered as sources of domestic value added (see Koopman et al. (2010), Stehrer et al. (2012) and Stehrer (2012), for detailed discussions).

The imports of a given country can be disentangled by using the same approach described above (Stehrer et al. (2012)). In order to discuss the characteristics of GVCs it is useful to calculate the value added that is embodied in exports but returns back home (embedded in imports) and is later embodied in new exports. This measure provides insights on the existence of GVCs where some intermediates are sent abroad for transformation before the final stage of production in the initial country. For example, this would be the case of a country exporting parts and components of an automobile, which are transformed abroad and reimported for final assembly before being exported.

To estimate this re-exported domestic value added in imports (RDVAiM) we proceed in two steps. Firstly, the domestic value added embodied in imports (DVAiM) is obtained. Secondly, the coefficient that results from dividing the level of DVAiM by total imports is applied to FVAiX ratio. In order to compute DVAiM the strategy is similar to the one presented above. Country r ’s imports from the other countries are denoted by m^r and this vector of dimension $NC \times 1$ includes bilateral import values of country r from

other countries as positive entries and zeros otherwise. The domestic value added in a country's imports is then calculated as:

$$\text{DVAiM}^r = v^r L^{rr} m^r \quad (4)$$

Equation 4 picks up the off-diagonal blocks of the rows of country r in the global inverse Leontief, which are pre-multiplied by country r 's input coefficients and post-multiplied by country r 's bilateral imports. Koopman et al. (2010) shows that subtracting this re-imported domestic value added from the domestic value added content of exports, i.e., equation (1) - (4), yields the "value added in exports" (VAX) as also defined in Johnson and Noguera (2012a)(see Stehrer (2013), for a detailed bilateral assessment). Next, taking I as $1 \times NC$ vector of ones:

$$\text{RDVAiM}^r = \frac{\text{DVAiM}^r}{I m^r} \text{FVAiX}^r \quad (5)$$

yields the proposed measure of the re-exported domestic value added in imports.

3 External euro area linkages

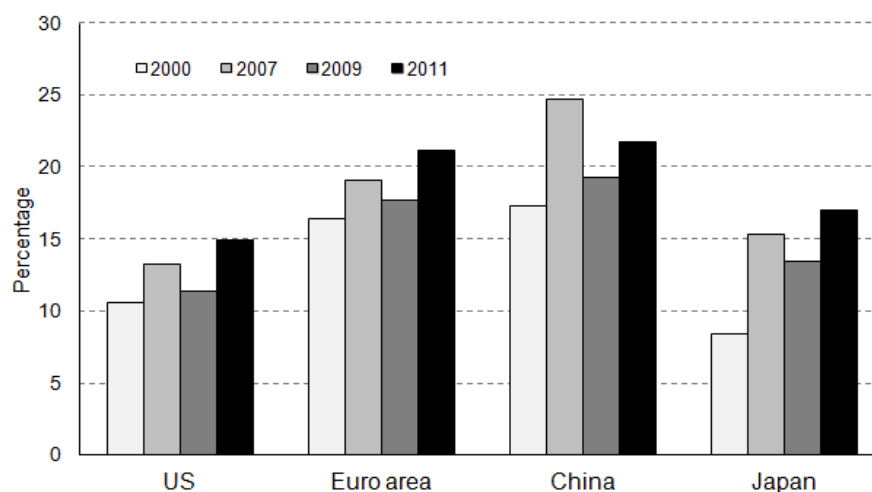
This section presents the patterns of FVAiX when the euro area is taken as a whole, i.e., the euro area is taken as "home country" and its member countries as "regions".¹ As previously discussed, the importance of GVCs in the euro area with respect to the rest of the world is gauged by the size of foreign (extra euro area) value added embedded in the production of goods and services sold only to extra-area countries.

The FVAiX is evaluated for years 2000, 2007, 2009 and 2011, basing on the WIOD database. This time frame covers the beginning of the euro area and allows for the consideration of three relevant sub-periods, namely the pre-crisis (2000-2007), the great trade collapse (2007-2009) and the rebound of international trade (2009-2011).

Figure 1 and table 1 show that GVCs have been playing an important role in the euro area since its creation and are at present almost as important as in China. The FVAiX for the euro area stands at 21.2 per cent of total euro area exports in 2011, compared with 21.8 per cent in China, 14.9 per cent in the US and 17.0 per cent in Japan. Euro areas's participation in the global production processes increased substantially in the last decade. The FVAiX ratio in the euro are increased by 4.8 percentage points (p.p.) from 2000 to 2011. Comparing the developments in the euro area with those of

¹By the time this paper was written, the euro area comprised 17 countries: Austria, Belgium, Cyprus, Germany, Spain, Estonia, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia and Slovenia. This definition for the euro area is held constant throughout the paper.

Figure 1: Foreign value added in exports in major economies, as a percentage of total exports



Note: The euro area is taken as a whole, i.e., intra euro area trade flows are eliminated.

other large economies like US, China and Japan, there are important facts to mention. Firstly, the trade collapse implied a decrease in FVAiX in the four economies from 2007 to 2009, but this drop was particularly strong in the case of China, which had also recorded the strongest increase in the previous period. The high sensitiveness of Chinese GVCs to this shock and the comparatively higher resilience of GVCs in the euro area may point towards a different nature of the production linkages prevailing in these economies. Secondly, except in the case of China, there was a rebound of GVCs in the recent period as the FVAiX in 2011 surpassed that of 2007.

The results for euro area countries considered as “regions” of the monetary union show a significant diversity in terms of their FVAiX intensity, ranging from 13.7 per cent in Portugal in 2011 to 50.5 per cent in Luxembourg. When country-results are weighted by their share in extra euro area’s exports in 2011, the main contributors to the area’s FVAiX are Germany (6.6 p.p.), Netherlands (2.3 p.p.), France (2.2 p.p.), Italy (2.1 p.p.) and Ireland (2.0 p.p.).

In addition to the FVAiX, Table 1 provides figures for the DVAiM and RDVAiM indicators computed for the euro area, US, China, Japan and for individual euro area countries when only their extra-area trade relations are considered, i.e., if they are considered as “regions” of the euro area. These indicators can provide some clues on the position of each country in the GVCs. A large share of FVAiX may indicate its position as a downstream processor (near final consumption), while a relatively high share of DVAiM and RDVAiM may suggest a relatively upstream position in the GVCs. However, it is important to refer that such upstream position refers to the sequential stages of production and not to the organization of the GVC, i.e., it can

Table 1: Indicators of value added in trade - Euro area as a whole and members' extra euro area trade

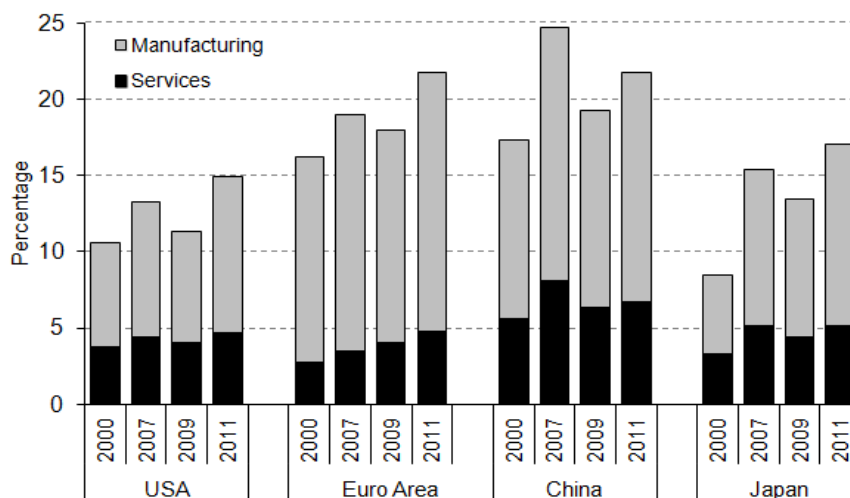
	Share in	Foreign value added				Domestic value added				Re-exported value added			
	extra area	in exports (FVAiX)				in imports (DVAiM)				in imports (RDVAiM)			
	gross exports	% extra area exports				% extra area imports				% of extra area exports			
	2011	2000	2007	2009	2011	2000	2007	2009	2011	2000	2007	2009	2011
AUT	4.1	12.8	16.0	14.8	17.6	7.4	8.8	7.6	7.3	0.9	1.4	1.1	1.3
BEL	5.3	20.7	20.7	19.9	24.1	5.6	6.8	5.8	5.1	1.1	1.4	1.2	1.2
CYP	0.1	17.4	13.7	15.2	17.2	5.2	6.7	6.2	5.1	0.9	0.9	0.9	0.9
DEU	36.4	14.4	17.7	15.7	18.7	7.1	8.5	7.5	7.4	1.0	1.5	1.2	1.4
ESP	6.5	14.0	18.6	14.7	19.5	5.3	6.3	5.6	4.9	0.7	1.2	0.8	1.0
EST	0.2	31.0	24.3	21.6	23.7	7.7	8.8	7.2	6.6	2.4	2.1	1.5	1.6
FIN	2.4	19.8	23.8	22.2	26.2	6.2	6.8	5.8	5.3	1.2	1.6	1.3	1.4
FRA	14.4	13.3	15.5	13.9	16.4	5.7	6.8	6.0	5.7	0.8	1.1	0.8	0.9
GRC	1.3	22.1	20.0	16.7	17.2	4.6	6.0	4.9	4.4	1.0	1.2	0.8	0.7
IRL	4.4	34.3	30.6	33.5	36.2	5.1	4.8	3.8	3.5	1.7	1.5	1.3	1.3
ITA	12.7	12.2	15.5	13.5	17.4	5.3	6.9	5.7	5.0	0.7	1.1	0.8	0.9
LUX	1.4	33.9	37.3	40.1	50.5	3.9	3.8	3.0	2.5	1.3	1.4	1.2	1.3
MLT	0.1	31.4	25.4	21.6	23.3	7.1	6.9	6.1	5.4	2.2	1.8	1.3	1.3
NLD	7.7	21.4	23.5	22.4	27.4	4.6	5.0	4.4	3.9	1.9	1.2	1.0	1.1
PRT	0.9	12.6	14.9	13.2	13.7	5.2	5.9	5.4	4.8	0.7	0.9	0.7	0.7
SVK	1.1	26.9	30.3	26.2	27.0	9.5	11.4	10.0	9.3	2.6	3.4	2.6	2.5
SVN	0.8	14.8	17.7	17.0	18.5	8.1	10.5	8.1	7.4	1.2	1.9	1.4	1.4
EA	100	16.4	19.1	17.7	21.2	6.0	7.1	6.1	5.7	1.0	1.4	1.1	1.2
Memo:													
USA	-	10.6	13.3	11.4	14.9	8.2	5.6	4.9	4.6	0.9	0.7	0.6	0.7
CHN	-	17.3	24.7	19.3	21.8	1.2	3.0	3.1	3.2	0.2	0.7	0.6	0.7
JPN	-	8.5	15.4	13.4	17.0	2.6	2.1	1.7	1.5	0.2	0.3	0.2	0.3

Note: Results for euro area member countries' eliminate intra euro area trade flows. Therefore, results presented for the euro area as a whole are compatible with the aggregation of indicators for member countries.

refer to very different kinds of activities like production of raw materials or design and R&D. An important result that emerges is that the values for the DVAiM and RDVAiM in the euro area as a whole tend to be higher than those for China and Japan but somewhat closer to those of US in DVAiM. The scale of the euro area economy, the types of products exported and the organizational choices of its firms are key determinants for this relatively high share of value added re-imported from extra-area countries. A broader discussion of these aspects is taken up in section 5, where the analysis sheds light on the role of the German economy to this result for the euro area. The developments of FVAiX and DVAiM in China from 2000 to 2011 point towards a progressive “upstreamness” of its exports. In fact, in this period Chinese FVAiX increased relatively less than its DVAiM. Nevertheless, this type of analysis is only approximate and more precise and elaborate measures of “upstreamness” exist in the literature (see, for example, Antras et al. (2012)).

Figure 2 breaks down the FVAiX between manufacturing and services for the major economies. Unsurprisingly, the largest share corresponds to the manufacturing sector.

Figure 2: Foreign value added in exports - Manufacturing and Services, as a percentage of total exports

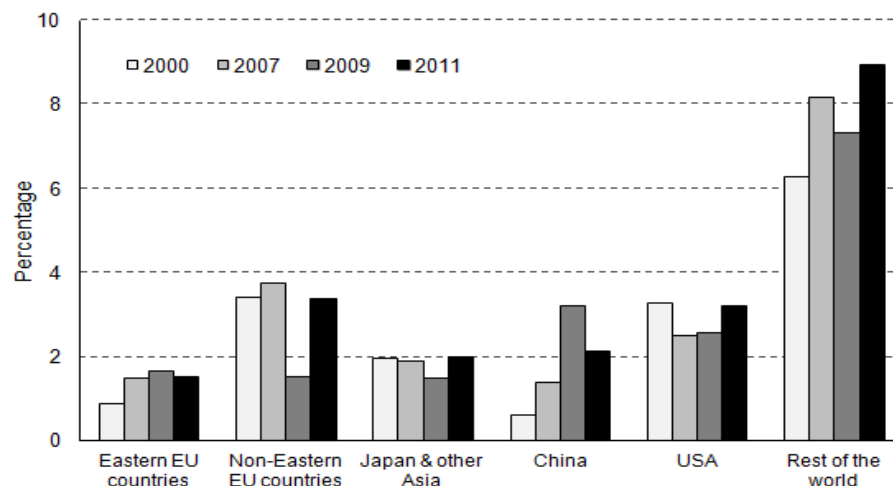


Note: The euro area is taken as a whole, i.e., intra euro area trade flows are eliminated.

This is a stylized feature in GVCs' literature, as manufacturing represents the core of the tradable sector. Nevertheless, the FVAiX attributed to the services sector has increased its share in extra euro area exports from 2.8 per cent in 2000 to 4.8 per cent in 2011, confirming the increasing importance of these activities in the overall functioning of European GVCs. Contrary to what is observed in other major economies, this sector did not reduce its importance from 2007 to 2009, not even in absolute terms.

One important exercise that is made possible by the existence of global input-output matrices like the WIOD is the decomposition of the FVAiX by country of origin. Figure 3 provides information on the production linkages of the euro area with some other country groups. The relevance of the non-Eastern EU countries (United Kingdom, Denmark and Sweden) as a source of value added embodied in the euro area's exports is high (3 per cent in the average of the period 2000-2011). Nevertheless, this percentage decreased to half during the trade collapse period, which may interlink with the specific nature of the production linkages or be the result of important exchange rate shifts. The Eastern EU countries (Bulgaria, Czech Republic, Hungary, Lithuania, Latvia, Poland and Romania) have increased their relevance as origins of value added in euro area exports, reaching 1.5 per cent in 2011 and did not decline from 2007 to 2009. In addition, Japan & other Asia and the US show a stable share (averages of 1.8 and 2.9 per cent in the period, respectively), while China recorded a very significant increase (from 0.6 per cent in 2000 to 2.1 per cent in 2011), surpassing Eastern EU countries. The largest share of euro area's FVAiX is originated in the block "Rest of the world", which includes oil producers. The FVAiX originated in this geographical block increased from near 6 per cent in 2000 to about 9 per cent in 2011.

Figure 3: Euro area as whole: foreign value added in exports by origin (in % of extra euro area exports)



Eastern EU countries: Bulgaria, Czech Republic, Hungary, Lithuania, Latvia, Poland and Romania. Non-Eastern EU countries: United Kingdom, Denmark and Sweden. Japan and other Asia: Japan, Indonesia, India, South Korea and Taiwan.

4 Internal euro area linkages

This section assesses the supply linkages between euro area countries, which implies restricting the analysis to intra-area trade of internally generated value added. It is clear that some of these internal value added flows would not exist in reality if extra-euro trade was not present. For example, if all energy was produced outside the area, internal trade and even production would be impossible in this framework. Therefore, this section must be interpreted as an analysis of production linkages existing inside the euro area but in a context where the latter is integrated in the world economy.

Table 2 provides information on the flows of value added that are traded between country-pairs in 2011. The geographical decomposition of each country's value added exported to the euro area is presented by row. Therefore, the marginal distribution along the row dimension represents the share of a country as supplier of value added, while the marginal distribution on the column dimension represents the share of the country as user of value added. The table shows that Germany plays the largest role in the internal euro area linkages, representing 28.8 per cent of value added supplied and 23.0 per cent of value added consumed. Other large suppliers come at a far distance, namely France (14.8 percent), Netherlands (12.5 percent) and Italy (12.2 percent). In terms of users of intra euro area value added the ranking changes, with France (18.0 percent), Italy (13.2 percent) and Spain (10.1 percent) following Germany.

Table 2: Breakdown of intra euro area value added flows: Bilateral linkages - 2011

To: From:	AUT	BEL	CYP	DEU	ESP	EST	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NLD	PRT	SVK	SVN	Sum
AUT	-	0.2	0.0	2.6	0.2	0.0	0.0	0.3	0.0	0.0	0.7	0.1	0.0	0.1	0.0	0.1	0.1	4.4
BEL	0.2	-	0.0	2.2	0.6	0.0	0.1	1.8	0.1	0.1	0.8	0.4	0.0	1.5	0.1	0.0	0.0	8.0
CYP	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
DEU	4.0	2.8	0.0	-	2.8	0.1	0.7	7.2	0.5	0.5	4.9	0.5	0.0	3.4	0.5	0.6	0.2	28.8
ESP	0.2	0.6	0.0	2.2	-	0.0	0.1	2.9	0.2	0.2	1.7	0.2	0.0	0.6	1.4	0.0	0.0	10.3
EST	0.0	0.0	0.0	0.0	0.0	-	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
FIN	0.0	0.1	0.0	0.5	0.1	0.1	-	0.1	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	1.3
FRA	0.3	1.9	0.0	4.9	2.7	0.0	0.1	-	0.2	0.3	2.6	0.3	0.0	1.0	0.3	0.1	0.1	14.8
GRC	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	-	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
IRL	0.0	0.2	0.0	0.6	0.3	0.0	0.0	0.3	0.0	-	0.3	0.0	0.0	0.2	0.0	0.0	0.0	2.0
ITA	0.7	0.6	0.0	4.1	1.7	0.0	0.1	3.1	0.5	0.2	-	0.1	0.1	0.5	0.2	0.1	0.2	12.2
LUX	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.1	-	0.0	0.0	0.0	0.0	0.0	0.9
MLT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.1
NLD	0.2	3.0	0.0	4.2	1.0	0.0	0.3	1.4	0.2	0.3	1.5	0.1	0.0	-	0.2	0.1	0.0	12.5
PRT	0.0	0.1	0.0	0.3	0.7	0.0	0.0	0.3	0.0	0.0	0.1	0.0	0.0	0.1	-	0.0	0.0	1.7
SVK	0.2	0.0	0.0	0.5	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	-	0.0	1.2
SVN	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	-	1.2
Sum	6.1	9.9	0.2	23.0	10.1	0.2	1.7	18.0	1.9	1.8	13.2	1.7	0.2	7.6	2.8	1.1	0.7	100.0

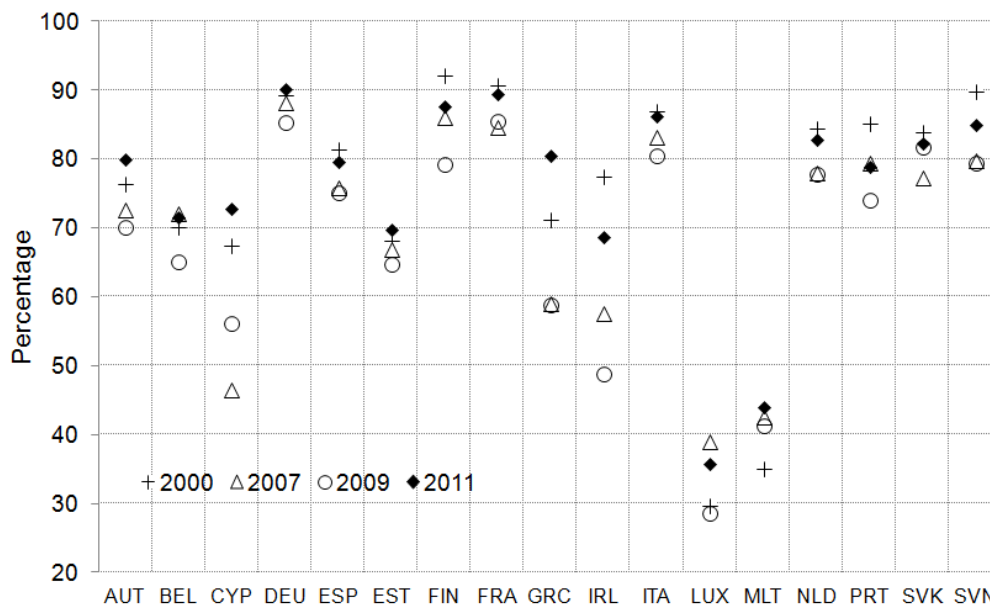
Note: Domestic value added in exports from row country to column country, as percentage of total intra euro area value added trade. Cells above 2 per cent are shaded in light grey and above 4 per cent in dark grey.

Unsurprisingly, the key bilateral linkage lies between Germany and France, each one being the other's main client and supplier.

There is another set of results that emerges from Table 2. The difference between countries' marginal distributions in the row and column dimensions can be interpreted as the "trade in value added balance" within the euro area. These numbers suggest that Germany runs a surplus in the intra euro area "trade in value added balance". A similar position is found for Netherlands, whereas France shows a deficit. The similar magnitude of shares in the value added supplied and consumed within the euro area for Spain and Italy suggests a position close to balance and a very small deficit, respectively.

The sectoral dimension of intra-area production linkages has changed from 2000 to 2011. Figure 4 presents the share of manufacturing in each country's total supply of value added to the euro area in this period. The most striking feature is that this share decreased from 2000 to 2011 in many countries and even more from 2007 to 2009. The resilience of services in this period was also observed in the extra euro area analysis. The countries that rely less on manufacturing are Luxembourg and Malta with shares around 40 percent, while Germany shows the largest share for manufacturing in its role as an euro area supplier in 2011 (90 per cent).

Figure 4: Share of manufacturing in intra euro area value added flows: 2000-2011



The analysis of the product dimension within euro area GVCs can be detailed in a bilateral way. This makes it possible to identify whether specialization patterns are partner-specific or common across euro area partners. Table 3 presents the share of manufacturing in bilateral intra-area value added flows and the numbers below 50 per cent are shaded in gray. Luxembourg and Malta consistently show low shares for manufacturing (high shares for services). Conversely, more than half of the value added moving from most euro area countries into Ireland and Luxembourg corresponds to services. The position of Ireland and Luxembourg as users of services in the euro area is consistent with their role as headquarter of multinational corporations and financial center, respectively.

5 Global value chains for individual euro area countries

This section studies the role of GVCs taking individual euro area countries as they are usually treated, i.e., as autonomous countries trading with the rest of the world. Therefore, both intra and extra area value added flows are considered. As in the previous sections, the analysis proceeds along the aggregate, geographical and sectoral dimensions.

Figure 5 reports FVAiX as a percentage of total exports of each euro area country from 2000 to 2011. As expected, substantial differences emerge across countries. In

Table 3: Share of manufacturing in intra euro area value added flows: Bilateral linkages 2011

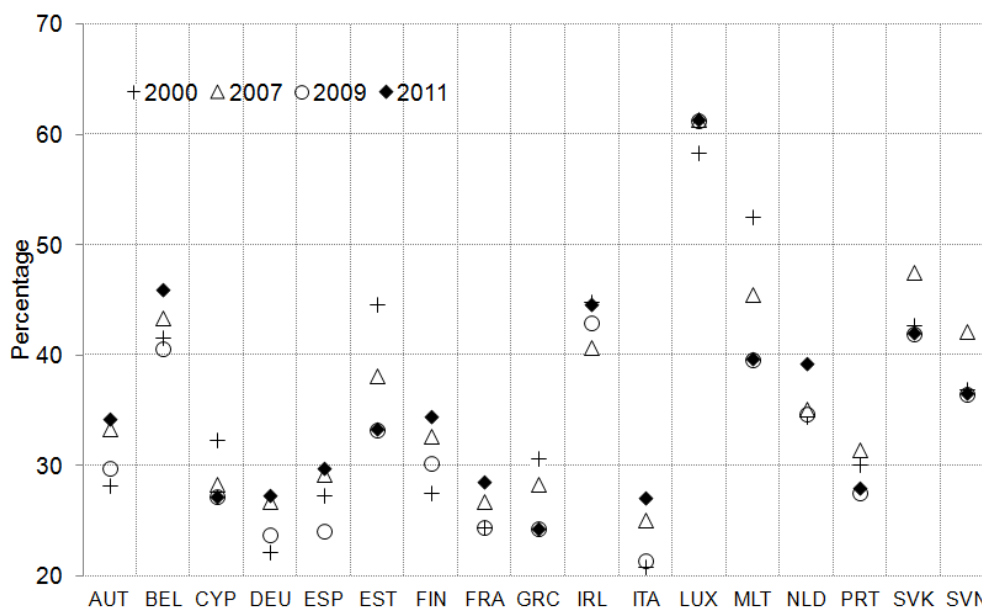
To: From:	AUT	BEL	CYP	DEU	ESP	EST	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NLD	PRT	SVK	SVN	Avg
AUT	-	48	60	85	71	74	67	91	78	36	83	10	21	60	61	63	82	62
BEL	51	-	71	82	51	61	62	80	72	37	78	31	48	69	61	66	54	61
CYP	85	83	-	75	61	9	95	91	69	49	94	13	47	77	76	52	30	63
DEU	92	80	85	-	85	92	92	97	86	55	95	52	75	89	93	96	94	85
ESP	73	60	93	85	-	72	66	85	91	31	85	7	90	60	85	91	93	73
EST	32	49	19	86	64	-	73	85	38	13	89	4	6	46	89	86	77	54
FIN	79	70	77	96	78	77	-	95	94	48	93	26	39	83	76	90	92	76
FRA	92	89	95	98	80	85	88	-	89	55	97	44	90	79	91	95	87	85
GRC	68	46	92	87	69	46	90	85	-	19	92	3	64	60	80	89	90	68
IRL	51	85	90	92	47	58	35	80	76	-	42	8	41	55	51	61	60	58
ITA	90	70	91	93	80	89	77	91	81	24	-	36	88	75	90	91	89	78
LUX	23	23	11	49	78	15	33	33	94	6	34	-	55	53	18	42	47	38
MLT	15	25	54	70	48	1	11	44	67	12	34	7	-	30	51	8	53	33
NLD	82	85	85	89	57	87	71	88	77	50	90	22	72	-	83	47	90	73
PRT	70	63	92	90	79	80	89	85	90	16	73	55	76	73	-	92	91	76
SVK	78	67	63	89	92	75	71	91	88	35	91	10	14	34	71	-	80	66
SVN	63	30	69	94	85	94	79	94	84	45	88	36	78	76	93	91	-	75
Avg	65	61	72	85	70	63	69	82	80	33	79	23	57	64	73	73	76	

Note: Domestic value added in exports from row country to column country, as per percentage of total euro area value added exports. Cells below 50 per cent are shaded in grey.

2000 FVAiX ranged between 21 per cent (Italy) and 58 per cent (Luxembourg), with larger countries showing lower values (Germany, France, Italy and Spain). The foreign value added content of euro area countries' exports increased, on average, by 4.5 percentage points from 2000 to 2011. Finland, Austria, Italy and Germany experienced a strong growth in the foreign content of exports, while Greece, Cyprus and Portugal witnessed an important reduction from 2000 to 2011. Although, the figure suggests a quite generalized increase in FVAiX during the whole period, it also shows differences across sub-periods. In general, during the 2000's the foreign content of exports grew substantially in the majority of euro area countries, whereas during the great trade collapse, it generally decreased. These developments are broadly consistent with those reported by other studies on vertical specialization in European economies until the mid 2000s (e.g. Backer and Yamano (2012) and Breda and Cappariello (2010)). Nevertheless, differences in sectoral classifications, the exclusion of energy products and the degree of disaggregation of the input-output table lead to different results in terms of levels.

Another relevant dimension, also discussed in previous sections is the magnitude of the re-exported domestic value added in imports as an indirect indicator of the nature of the GVCs (Figure 6). The numbers are generally low in most countries (below 0.4 percent), with the notable exception of Germany and, to a lesser extent, Nether-

Figure 5: Foreign value added in exports: 2000-2011

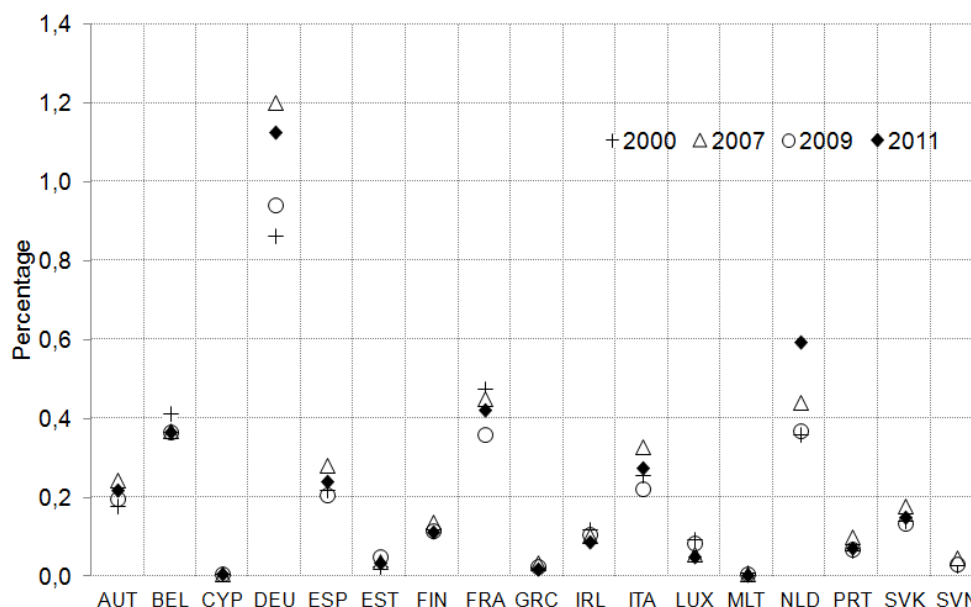


lands. The comparatively larger values of Germany (1.1 per cent in 2011) are partly explained by its specialization in the production of transport equipment. The technology in the automotive sector has been defined as “spider-shaped”, i.e., multiple parts and components come together to assemble the final product, in contrast to a “snake-shaped” technology where goods move in a sequential manner from upstream to downstream stages with value being added along the way (Baldwin and Venables (2013)). A “spider-shaped” production process makes it easier to configure production in such a way that both the most upstream stage of the production process (e.g., product design) and the assembly stage remain in the home country, thus turning RDVAiM high.

Timmer et al. (2013) argues that developments in German automobile industry in the last two decades partly deviated from those visible at global level. Firstly, in the global car industry assembly stages have largely been kept close to consumption markets mainly to facilitate penetration and reduce transport costs. Secondly, there has been a strong global/regional integration in the production of parts and components. Nevertheless, the delocalization of the final stages of production in Germany’s automobile industry is relatively weaker than in other European automobile industries because of its orientation towards high quality segments, which are signalled by the fact that they are “made in Germany”. In fact, FVAiX in Italy and France is in line with that of Germany, but the RDVAiM is much lower.

The analysis of the FVAiX by source country adds insights to the analysis of GVCs

Figure 6: Re-exported domestic value added in imports: 2000-2011



in the euro area. Figure 7 decomposes the FVAiX of each euro area country by main geographic origins from 2000 to 2011, while Figure 8 presents the geographical structure of this indicator in 2011 (numbers are presented in Appendix). Two results emerge from this empirical analysis. Firstly, the share of the (remaining) euro area countries as sources of FVAiX is typically the highest, i.e., the euro area is, in most cases, the dominant part of the GVC for each individual member. In 2000 near 40 per cent of foreign value added embedded in the average euro area country’s exports was sourced inside the area and in 2011 this number was 33 per cent. Secondly, at least for the largest economies, this share is more stable than that attached to other sources of foreign value added, i.e., the change in total FVAiX is mostly due to changes in value added sourced from other trade blocks.

Some countries constitute exceptions to this general pattern. Luxembourg and Ireland have a very large share of non-Eastern EU countries (UK, Denmark and Sweden) as sources of FVAiX. This is partly related with the linkages of Luxembourg with the UK financial center and with Ireland’s role as headquarters of anglo-saxon and nordic multinational corporations. In addition, Slovakia shows a strong link with and non-euro-area Eastern EU countries (notably the Czech Republic), which is related with the strong regional production linkages already in place before its euro area accession. Moreover, Finland and Netherlands present a large share of FVAiX sourced in the “Rest of the world”.

Figure 7: Decomposition of foreign value added in exports by origin: 2000-2011

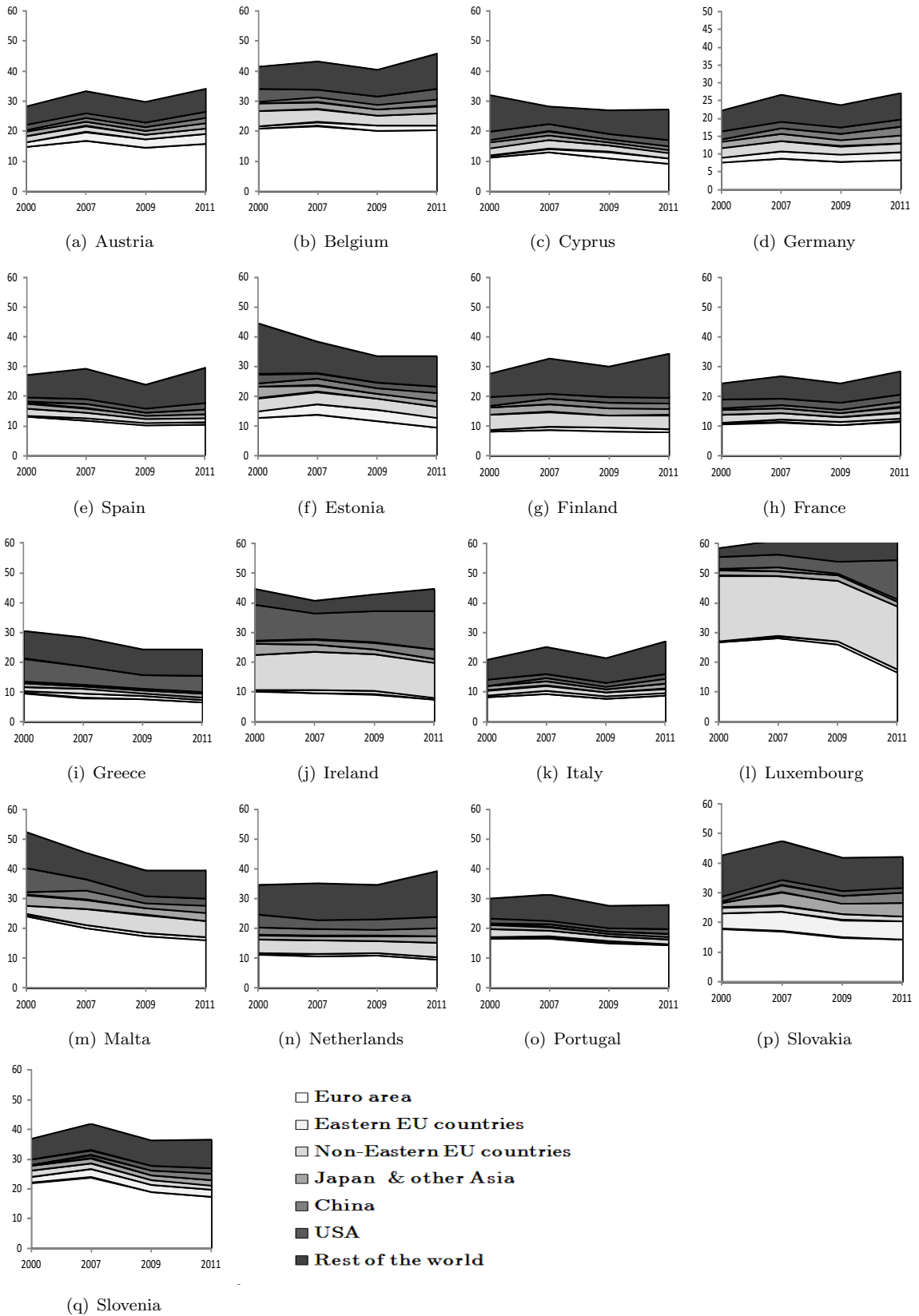
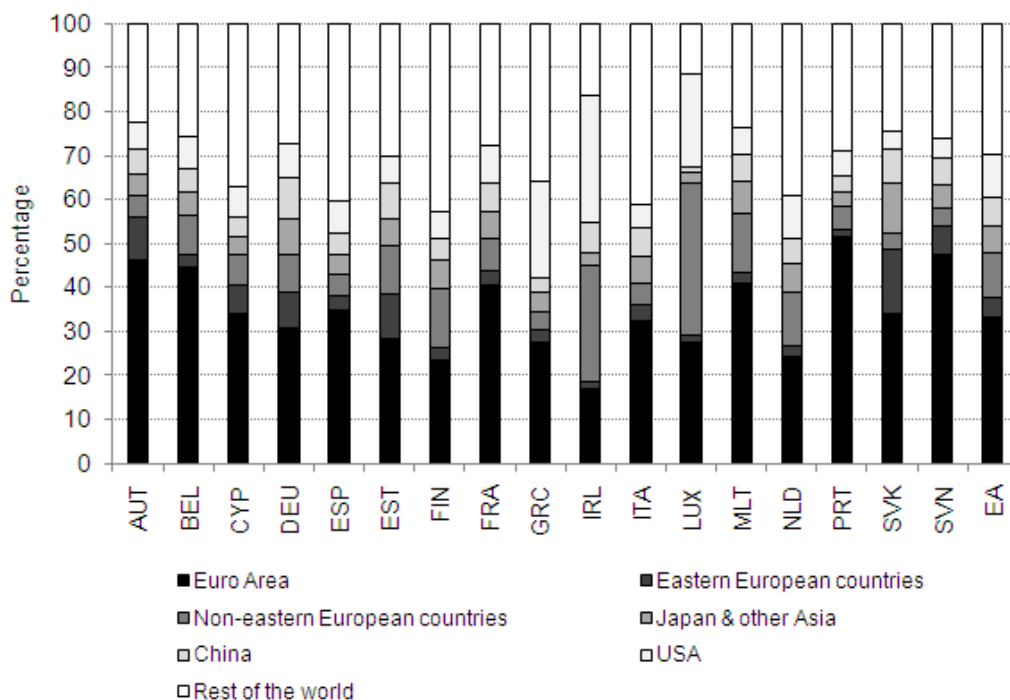


Figure 8: Decomposition of foreign value added in exports by origin (in % of total foreign value added in exports), 2011



In the case of Netherlands, this should be connected with its role as a global trade hub and also as headquarters of a major oil company. In fact, between 2000 and 2007, the increase of the FVAiX sourced in the “Rest of the world” is observed in several countries is partly due to the strong increase of oil prices imported from producer countries. Finally, it is important to refer the role of China as source of FVAiX in euro area countries. Although China is widely referred as a key part of GVCs, it represents less than 2 per cent of FVAiX for about half of euro area countries. Nevertheless, China’s relevance as input provider increased rapidly in the overall period under analysis with a slowdown just in 2009. In 2011, the value added sourced from China and embodied in euro area exports is larger than that coming from the Eastern EU economies, similar to that of Japan & other Asia but still lower than that of USA.

Table 4 proceeds with the geographical decomposition of FVAiX of euro area countries taken individually, breaking down the euro area as a source. Each row presents the share of FVAiX sourced from each column country and the diagonal corresponds to the DVAiX. The results presented are related to those reported in table 2, when the intra euro area value added flows were discussed. The striking point is the very high importance of Germany as an origin of FVAiX for all other euro area countries, which reinforces the conclusion that Germany plays a core role in the euro area GVCs. In addition, some other known value chains are identified. France and Netherlands are important sources of Belgium’s FVAiX and the same happens for Spain which is as an

Table 4: Foreign value added in exports by origin - 2011

From: To:	AUT	BEL	CYP	DEU	ESP	EST	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NLD	PRT	SVK	SVN	Sum
AUT	65.8	0.6	0.0	9.4	0.7	0.0	0.2	1.1	0.0	0.1	1.9	0.1	0.0	0.8	0.1	0.5	0.2	81.6
BEL	0.4	54.0	0.0	5.7	1.2	0.0	0.3	3.4	0.1	0.5	1.3	0.4	0.0	6.8	0.2	0.1	0.0	74.5
CYP	0.3	0.6	72.8	2.2	0.8	0.2	0.1	1.0	1.6	0.1	1.4	0.1	0.1	0.7	0.1	0.1	0.0	82.1
DEU	0.9	0.9	0.0	72.7	0.8	0.0	0.3	1.8	0.0	0.2	1.5	0.1	0.0	1.4	0.1	0.2	0.1	81.1
ESP	0.3	0.6	0.0	3.2	70.3	0.0	0.2	2.6	0.0	0.2	1.6	0.0	0.0	1.0	0.5	0.1	0.0	80.7
EST	0.3	0.5	0.0	3.1	0.4	66.7	2.5	0.7	0.0	0.2	0.8	0.1	0.0	0.7	0.1	0.1	0.1	76.2
FIN	0.3	0.6	0.0	3.1	0.4	0.4	65.5	0.8	0.1	0.2	0.8	0.0	0.0	1.2	0.1	0.1	0.0	73.6
FRA	0.3	1.2	0.0	4.9	1.5	0.0	0.1	71.5	0.0	0.2	1.7	0.1	0.0	1.1	0.2	0.1	0.0	83.0
GRC	0.2	0.6	0.1	1.8	0.5	0.0	0.1	0.8	75.7	0.1	1.8	0.0	0.0	0.6	0.0	0.0	0.0	82.4
IRL	0.2	0.6	0.0	2.2	0.8	0.0	0.1	1.1	0.0	55.4	1.0	0.1	0.0	1.2	0.2	0.0	0.0	63.0
ITA	0.5	0.6	0.0	3.3	1.0	0.0	0.1	1.6	0.1	0.2	72.9	0.1	0.0	1.0	0.1	0.1	0.1	81.7
LUX	0.6	3.6	0.0	4.3	2.5	0.0	0.1	2.3	0.0	0.6	0.9	38.7	0.0	1.5	0.1	0.2	0.0	55.5
MLT	0.7	0.7	0.1	3.4	0.9	0.1	0.2	4.2	0.1	0.3	4.5	0.0	60.3	1.0	0.1	0.1	0.0	76.6
NLD	0.2	1.7	0.0	4.0	0.8	0.0	0.3	1.4	0.0	0.2	0.7	0.1	0.0	60.8	0.1	0.1	0.0	70.3
PRT	0.2	0.6	0.0	3.0	6.2	0.0	0.1	1.5	0.0	0.2	1.4	0.1	0.0	0.9	72.1	0.1	0.0	86.4
SVK	0.9	0.5	0.0	7.2	0.7	0.0	0.2	1.7	0.0	0.1	1.7	0.1	0.0	0.9	0.1	58.0	0.1	72.3
SVN	2.1	0.7	0.0	5.9	0.8	0.0	0.2	1.6	0.1	0.1	4.5	0.1	0.0	0.8	0.1	0.4	63.5	80.8

Note: Foreign value added in exports to row country from column country, as percentage of total row country exports. Cells above 3 per cent are shaded in grey.

important source of Portuguese FVAiX. Finally, Italy is identified as a relevant supplier for Slovenia and France and Italy are also important Malta's suppliers.

6 Conclusions

Global value chains have been changing the organization of production across the world, with each country specializing in particular activities within industries. Because of these vertical supply linkages, intermediates move across borders several times before being assembled into a final good. As a result, traditional trade statistics routinely used in assessing a country's production linkages became poorly informative. This paper takes a descriptive approach and studies the role of GVCs in shaping the economic integration of the euro area. This aims at providing some insights on the potential effects of economic and monetary integration within a region, which could be useful for other parts of the world facing similar integration processes, like Asia.

In methodological terms, the article adopts the framework suggested by Koopman et al. (2010) and Stehrer (2012) to break down gross exports according to their sources of value added. The key data ingredient is the World Input-Output Database (WIOD), which provides global product/sector production linkages, and the time period studied is 2000-2011. In this way it is possible to cover the years just after the creation of the

euro area, the eve of the crisis, the great trade collapse and, finally, the subsequent rebound of international trade.

We find evidence of an increasing trend in the share of foreign value added in exports for the euro area as a whole over the 11-year period, with a cyclical pattern evident during the trade collapse. The foreign production linkages of the euro area are comparable in magnitude with those of other important trade blocks, including China, and there is an increasing participation of services in the value chains.

In addition, the bilateral intra euro area value added flows make it clear that Germany plays a core role in such production linkages, notably with France. Moreover, manufacturing retains a dominant role in most of these linkages. The analysis also shows that the euro area is the main source of foreign value added in exports for most member countries and its share is more stable than that of other trade blocks. In other words, the growing relevance of external suppliers does not reflect a weakening of the production links within the euro area, being instead a substitution of domestic value added by extra euro area sourcing.

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Appendix

Table 5: Decomposition of foreign value added in exports by origin: 2000-2011 (as percentage of total exports of each country)

	Total				Euro area				Eastern EU				Non-eastern EU				Japan & other Asia				China				USA				Rest of World						
	2000	2007	2009	2011	2000	2007	2009	2011	2000	2007	2009	2011	2000	2007	2009	2011	2000	2007	2009	2011	2000	2007	2009	2011	2000	2007	2009	2011	2000	2007	2009	2011	2000	2007	2009
AUT	28.2	33.3	29.7	34.2	14.7	17.0	14.6	15.8	1.7	2.9	2.7	3.3	2.0	1.9	1.6	1.7	1.7	1.5	1.3	1.8	0.4	1.2	1.2	1.9	1.7	1.5	1.5	2.0	5.9	7.3	6.8	7.7			
BEL	41.5	43.4	40.6	46.0	20.9	21.9	20.2	20.4	0.8	1.3	1.6	1.4	4.9	4.3	3.5	4.1	2.6	2.3	2.0	2.5	0.7	1.6	1.7	2.4	4.3	2.7	2.7	3.5	7.3	9.4	8.9	11.8			
CYP	32.3	28.3	27.1	27.2	11.3	13.1	10.9	9.3	0.6	1.1	2.2	1.7	2.4	2.9	2.1	2.0	2.0	1.6	1.2	1.1	0.8	1.3	0.9	1.2	2.7	2.4	1.6	1.9	12.5	5.9	8.2	10.1			
DEU	22.2	26.7	23.8	27.3	7.7	8.8	7.9	8.4	1.4	2.0	2.1	2.2	2.6	2.8	2.2	2.4	1.9	2.1	1.8	2.3	0.5	1.5	1.7	2.5	2.4	2.0	1.8	2.1	5.7	7.5	6.2	7.5			
ESP	27.2	29.2	24.0	29.7	13.2	11.8	10.2	10.4	0.4	0.8	0.9	0.9	2.4	1.9	1.4	1.5	1.7	1.4	1.1	1.4	0.4	1.3	0.9	1.4	1.6	1.7	1.5	2.2	7.6	10.1	8.0	11.9			
EST	44.5	38.1	33.2	33.3	12.6	13.7	11.5	9.4	2.4	3.7	3.8	3.4	4.3	4.0	3.8	3.6	3.8	2.1	1.6	2.0	1.2	2.4	1.9	2.8	3.1	1.6	1.8	1.9	17.2	10.5	8.7	10.1			
FIN	27.5	32.6	30.1	34.5	8.2	8.8	8.3	8.1	0.7	1.0	1.2	1.0	5.1	5.0	4.2	4.7	2.3	2.6	2.3	2.2	0.6	1.9	1.8	1.6	3.1	1.7	1.9	2.2	7.6	11.6	10.3	14.7			
FRA	24.4	26.7	24.3	28.5	10.7	11.2	10.4	11.5	0.4	0.9	0.9	0.9	2.7	2.4	1.9	2.0	1.6	1.5	1.3	1.8	0.5	1.1	1.3	1.9	2.9	2.1	2.2	2.4	5.6	7.5	6.5	7.9			
GRC	30.7	28.3	24.2	24.3	9.7	8.1	7.7	6.7	0.6	1.2	0.9	0.8	1.4	1.7	1.0	1.0	1.4	1.0	0.9	1.1	0.3	0.6	0.5	0.7	7.8	6.0	4.8	5.4	9.4	9.7	8.4	8.7			
IRL	44.8	40.6	42.9	44.6	10.3	9.7	9.3	7.6	0.5	1.1	1.1	0.6	11.6	12.9	12.3	11.8	3.9	2.2	1.6	1.3	0.7	1.8	2.4	3.1	12.3	8.8	10.6	12.9	5.4	4.0	5.6	7.2			
ITA	20.8	25.1	21.4	27.1	8.3	9.4	7.8	8.8	0.5	1.1	0.9	1.0	1.8	1.8	1.2	1.3	1.3	1.4	1.0	1.7	0.4	1.1	1.0	1.8	2.0	1.4	1.3	1.5	6.6	8.9	8.0	11.1			
LUX	58.3	61.3	61.2	61.3	26.8	28.1	26.2	16.8	0.4	0.7	0.9	1.0	22.1	20.2	20.3	21.2	1.7	1.4	1.8	1.5	0.4	1.5	0.5	0.8	4.1	4.3	4.2	13.1	2.9	5.0	7.2	7.0			
MLT	52.6	45.5	39.5	39.7	24.2	20.1	17.6	16.3	0.6	1.1	0.9	0.9	2.9	5.5	6.0	5.4	3.5	3.0	2.3	2.8	0.9	3.1	1.8	2.5	8.1	3.7	2.3	2.4	12.2	9.0	8.7	9.4			
NLD	34.5	35.0	34.6	39.2	11.3	10.6	10.8	9.6	0.5	0.7	1.0	0.8	4.6	4.6	3.9	4.8	2.6	2.2	2.2	2.5	1.4	1.6	1.9	2.3	4.2	3.2	3.5	3.9	9.8	12.1	11.5	15.3			
PRT	30.0	31.4	27.5	27.9	16.7	16.7	15.0	14.3	0.4	0.6	0.6	0.5	2.7	1.9	1.6	1.5	1.5	1.2	0.9	1.0	0.3	0.9	0.8	1.0	1.7	1.2	1.3	1.6	6.7	8.8	7.4	8.0			
SVK	42.7	47.5	41.8	42.0	18.0	17.2	14.9	14.3	5.2	6.6	5.9	6.1	1.9	2.0	2.0	1.6	1.5	4.5	3.8	4.7	0.5	2.3	2.5	3.2	1.8	1.9	1.7	1.7	13.8	13.1	11.2	10.4			
SVN	36.9	42.2	36.4	36.5	22.0	24.0	18.9	17.4	2.1	2.8	2.5	2.4	2.1	1.9	1.6	1.5	1.6	1.7	1.6	1.8	0.5	1.1	1.6	2.3	1.7	1.5	1.6	1.6	7.0	9.2	8.7	9.6			

Note: In the decomposition block, cells above 5 per cent are shaded in light grey and above 10 per cent in dark grey.



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